Clinical Investigation

Tracheal Stenosis after Tracheostomy or Intubation

Review with Special Regard to Cause and Management

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To investigate the management outcomes of patients who developed tracheal stenosis after tracheostomy or intubation, we reviewed the courses of 45 patients who had experienced tracheal stenosis at a single institution, over 19 years from February 1985 through January 2004.

There were 38 tracheal and 7 infraglottic stenoses. Twenty-nine stenoses were associated with the stoma, 12 with the cuff, and 2 with the endotracheal tube resulting in infraglottic lesions; the remaining 2 were double stenoses. Eleven patients were treated by bronchoscopic surgery, and 34 patients were treated by tracheal or laryngotracheal resection. The overall success rate was 93%. The complication rate was 18%. A 2nd operation was required in 3 patients, and 1 of the 3 died of sepsis.

Our management strategy of treating tracheal stenosis with resection and end-to-end anastomosis has been associated with good outcomes. Management of infraglottic stenosis is difficult, particularly when there is a large laryngeal defect or when there have been previous surgical attempts at the same site. ***(Tex Heart Inst J 2005;32:154-8)***

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Iatrogenic airway injury after tracheotomy and endotracheal intubation continues to be a serious clinical problem.[1-3] Endotracheal tubes cause pressure injury to the glottis, which can result in severe commissural scarring that is difficult to treat.[1,2,4] Tracheotomy tubes can cause severe stomal stenosis in the trachea or infraglottic region.[1,2,5,6] Both methods of airway intubation can result in pressure necrosis caused by the tube's cuff, which is a preventable problem.[1,5,6] We reviewed postintubation tracheal stenosis in 45 patients with special regard to the cause and treatment of the stenoses.

Patients and Methods

Over a 19-year period from February 1985 through January 2004, 45 patients with postintubation tracheal stenosis were admitted to our department. In 21 patients, the stenosis was a complication of their hospital course in the intensive care unit. Other patients were referred from other hospitals. They included 34 male and 11 female patients, with an age range of 2–72 years (average, 38 years). This series does not include patients who experienced tracheal trauma without postintubation stenosis.

All patients' clinical records and physical findings were reviewed for causal factors, diagnostic methods, surgical therapies, and outcomes. The initial diagnostic evaluation had included plain radiography, computed tomography, or both. The length and severity of the stenosis were determined by endoscopic examination. The severity of the stenosis was classified as mild if less than 50% of the tracheal lumen was obstructed, moderate if the obstruction was 50% to 90%, or severe if 90% or more of the lumen was obstructed.

Thirty-eight patients had tracheal stenosis and 7 had infraglottic stenosis. The distribution of patients according to causal factors is shown in Table I. The severity of stenosis in 13 patients was mild, in 24 patients it was moderate, and in 8 patients it was severe. Table II shows the relationship between the location of a stenosis and the duration of intubation and tracheostomy, and the time interval for stenosis development after extubation or decannulation.

All patients underwent rigid bronchoscopy. If the severity of stenosis was mild and the stenosis was smaller than 1 cm in length, and if the lesions had neither circumferential scarring nor loss of cartilaginous support, bronchoscopic treatment was performed. Cryosurgery or forceps resection of endoluminal scars was adequate in these patients. Local steroid injection was performed to prevent restenosis. In the patients who had severe or moderate stenosis, resection was performed via a cervical incision. The addition of a right thoracotomy was required in 2 patients who had double stenoses.

Preoperative Preparation and Anesthesia. All surgical procedures were performed under general anesthesia, and with the use of standard techniques for airway operations. A rigid bronchoscope was used at the time of resection. Dilation was done serially, by means of dilators and pediatric bronchoscopes. After the stenotic segment was resected and the distal airway was divided, ventilation was performed through a spiral tracheal tube inserted in the distal tracheal segment. Often, existing stomas were used for intubation, especially in cases of infraglottic stenoses.

Tracheal Resection. To enable a healthy anastomosis, complete resection of the stenotic lesions was performed between proximal and distal disease-free cartilage. Careful mucomucosal approximation at the anastomosis was done by using interrupted sutures, with knots tied outside the lumen. In 15 patients absorbable sutures were used, and in 12 patients nonabsorbable sutures were used. We used 3-0 sutures in the adult patients and 5-0 sutures in the pediatric patients.

Two patients with double stenoses underwent dual resection instead of long-segment resection. Stomal stenoses were localized at the anterior wall of the trachea in both of these patients. Therefore, a partial resection of 2 tracheal rings was carried out at the stoma site via cervical incision. Then tracheal circular resection was performed via right thoracotomy. The distance between the 2 anastomoses was 5 and 6 tracheal rings, in these 2 patients.

Infraglottic Resection. In 4 of the 7 patients with infraglottic stenosis, complete resection of the trachea and anterior cricoid cartilage was done. Anastomosis of the trachea to the cricothyroid membrane or thyroid cartilage was performed. In the other 3 patients, who had a tracheal resection and cricotracheal anastomosis, a costal cartilage graft was used at the anterior wall of the infraglottic area because of the large defect caused by resection of the anterior cricoid cartilage and trachea. All anastomoses in these patients

TABLE I. Causal Factors behind Artificial Ventilation and Stenosis in 45 Patients

Causes behind artificial ventilation	**N**
Trauma	14
Acute attacks of chronic respiratory disease	9
Severe metabolic disorders	5
Neurologic disorders	8
Cardiopulmonary disorders (postoperative)	9
Causes or risk factors behind stenosis	**N**
Stomal stenosis	
Open tracheostomy	
Infection at stoma site	10
Cervical soft tissue trauma	6
Urgent tracheotomy	4
Pediatric age group	2
Hypotension	3
Percutaneous procedure	
High tracheostomy	5
Tracheal cartilage damage	1
Infection at stoma site	2
Hypotension	1
Cuff site	
Pediatric age group	2
Hypotension	6
Cervical soft tissue trauma	3

TABLE II. Relationships between Stenoses and the Duration of Intubation and Tracheostomy; and Intervals for Stenosis Development after Extubation or Decannulation

Location of Stenosis	**No. of Patients**	**Duration of Intubation** (days)	**Duration of Tracheostomy** (days)	**Interval until Stenosis Development*** (days)
Airway tube cuffs	14			
Endotracheal intubation only	10	10.9 (2–14)	—	32.3 (21–43)
Endotracheal intubation and tracheostomy	4	8.3 (6–14)	23.7 (20–26)	27.1 (17–41)
Stoma site	29			
Open tracheostomy	22	5.6 (4–14)	28.3 (16–52)	27.3 (11–52)
Percutaneous tracheostomy	7	4.4 (3–12)	60.9 (22–136)	19.8 (1–46)
Double stenosis (stoma and cuff)	2	13 and 18	8 and 15	15 and 28

*After extubation or decannulation

were done with interrupted 3-0 nonabsorbable sutures, with the knots tied outside the lumen.

Endoscopic follow-up study of the anastomosis was performed between postoperative days 7 and 15. An endoscopic resection sometimes was necessary to remove granulomata during this endoscopy. The long-term follow-up included endoscopic examination at 6 months after surgery.

The outcome was judged good if patients had no limitation in activity and good voice. Outcome was deemed satisfactory if the patients had symptoms of dyspnea on exertion and an adequate voice. Failure was determined by the need for reoperation or a permanent tracheostomy tube.

Results

The treatment results for tracheal and infraglottic stenosis are presented in Table III. Eleven patients were treated via bronchoscopy. Overall, 14 bronchoscopic procedures were performed. All of these patients had tracheal stenosis, and not infraglottic stenosis. The outcome was good in this group of patients. Twenty-seven patients were treated with tracheal resection and primary anastomosis. The length of resected segment ranged from 1.5 to 4 cm. In 23 patients, the treatment result was good. In 3 patients, granular tissue formed at the anastomosis line. These patients were managed by bronchoscopic removal of the granulomata. In 1 patient, restenosis occurred, and a 2nd resection was required. This patient was asymptomatic 9 months after the 2nd operation.

In 5 of the 7 patients who had infraglottic stenosis, the treatment outcome was good. Restenosis recurred in 2 patients. One patient, in whom costal cartilage graft had been used at the anterior wall, was not treated by bronchoscopic resection. After 5 months, reoperation was required: the anterior wall was resected partially and was closed with adjacent tissue. This patient could perform normal activities, but he died of chronic respiratory disease and pulmonary insufficiency 3 months after the 2nd operation. The other patient who experienced restenosis underwent tracheostomy and intubation. The surgery was not successful, and a 2nd operation was performed 7 months after the first. The anterior wall of the anastomosis was resected, and the costal cartilage graft was replaced. However, this procedure also failed, and severe infection developed. This patient died of sepsis 6 days later.

There were 11 sequelae in 6 patients. These are presented in Table IV. During the post-hospital period, 13 of the 45 patients died as a result of the primary disease. In 30 patients, the follow-up period ranged from 6 months to 7 years (mean, 3.2 years).

TABLE III. Results of Intervention for Tracheal and Infraglottic Stenosis

	Tracheal Stenosis	**Infraglottic Stenosis**	**Total No.** (%)
Good	34	4	38 (84.4)
Satisfactory	3	1	4 (8.8)
Failure	1	2	3 (6.6)
Total	38	7	45

TABLE IV. Postoperative Sequelae

Sequela	**Tracheal Stenosis** (n=27)	**Infraglottic Stenosis** (n=7)	**Total No.** (%) n=34
Granulation	3	0	3 (9)
Restenosis	1	2	3 (9)
Wound infection	1	1	2 (6)
Vocal cord dysfunction	0	2*	2 (6)
Death	0	1	1 (3)
Total	5	6	11

*One temporary

Discussion

Oral or nasal endotracheal tubes or tracheostomy tubes are most commonly used to deliver mechanical ventilatory support in respiratory failure.[7] Despite technological improvements and more skillful patient care in intensive care units, tracheal and laryngotracheal stenoses still constitute an important group of iatrogenic sequelae after intubation and tracheostomy.[1-7] The reported incidence of tracheal stenosis following tracheostomy and laryngotracheal intubation ranges from 0.6% to 21% and 6% to 21%, respectively.[5-7]

Tracheal stenosis mostly occurs at the cuff of the tube.[1,5,6] In our series, however, the percentage of cuff stenosis is lower than that reported in published series (31%). Large-volume, low-pressure cuffs markedly reduce the occurrence of cuff injury.[1] The most important reason for stenosis at the stoma site is damaged cartilage.[1,2,5,6] The tracheostomy stoma must not be made too large, nor should a large tube be inserted into a small stoma by force.[1,5,6] Wound sepsis and previous cervical or tracheal trauma negatively affect healing of the stoma.[1,7-10] In our series, wound sepsis was a causative factor in approximately 42% of the cases of stomal stenosis following open tracheostomy.

Although infraglottic stenosis most commonly results from endotracheal tube damage, it may occur

after damage of the 1st tracheal ring or cricoid cartilage during tracheostomy.[2,3,6,7] In our study, 5 patients had infraglottic stenosis secondary to percutaneous tracheostomy of the 1st tracheal ring and cricoid cartilage. High tracheostomy should be avoided insofar as possible.[1] If damage to this area is noticed during tracheostomy, the stoma site must be changed immediately.

Open tracheostomy has been proved to be a safe method.[11,12] Sequelae of open tracheostomies are more frequent than those of percutaneous procedures, but percutaneous tracheotomy procedures can also be associated with a high rate of complications, some fatal.[8,13] To prevent cartilage damage, particularly during percutaneous tracheostomy, excessive force must not be applied to the trachea, and placement of the stoma must be guided by bronchoscopy.[8-10,12,13] Whether tracheostomy is open or percutaneous, it should be undertaken only by physicians who are able to manage any eventual sequelae, by virtue of their experience and training.[8,9] We prefer open tracheostomy.

Conservative treatments may be carried out for stenoses smaller than 1 cm in length with no circumferential scarring and no loss of cartilaginous support.[14] In our series, 11 patients (85% of whom had mild stenosis) underwent bronchoscopic treatment with good results and without complication.

Tracheal resection followed by end-to-end anastomosis is now a well established technique performed under well established indications.[1-3,5,6] According to the literature, the success rate is 71% to 97%.[1-3,5,6] In our series, a satisfactory result was obtained in 96% of tracheal resections.

Resection of the long tracheal segment may be necessary in patients who have multiple stenoses. Resecting both segments in continuity can result in a tracheal defect too extensive for primary tracheal anastomosis.[2,3,6] Therefore, we preferred dual resection in 2 patients who had distinctly obstructive double stenoses with intervening areas of adequate lumen.

Lesions that involve the infraglottic larynx as well as the upper trachea are much more difficult to repair surgically.[1-4] Infraglottic stenoses caused by a high tracheostomy are more extensive lesions than are infraglottic stenoses due to endotracheal tubes. Although the outcomes of 5 patients treated in the present series were good, airway reconstruction failed in 2 other patients because of extensive infraglottic scarring, despite numerous attempts at correction. Costal cartilagoplasty is most often used in children,[15] but it may be used to repair large anterior wall defects after resection in adult patients with infraglottic stenoses, as in our patients.

The complication rate is generally low for tracheal lesions. Serious sequelae more often follow laryngotracheal resections.[1-7] In our series, the complication rate was 18% overall. The most common late complication was the formation of granulations at the suture line.[1,3,5,6] Granulations can usually be managed with bronchoscopic removal. Grillo[1] reported that this problem could largely be eliminated with the use of absorbable suture material and with meticulous surgical technique. In our series, there was no relationship between suture materials and sequelae. However, we have preferred absorbable sutures in recent years.

The incidence of postintubation stenoses can be reduced by use of large-volume, low-pressure cuffs, careful placement of the stoma, avoidance of large apertures, elimination of heavy or prying ventilatory connecting equipment, and meticulous care of the tracheostomy. The percutaneous procedure appears to be safe; but that should not encourage its use by inexperienced physicians. Bronchoscopic visualization during percutaneous tracheostomy is essential in reducing the procedure's complications. Although tracheal stenoses often are very easy to cure, the treatment of laryngotracheal stenoses is difficult, particularly when the laryngeal defects are large and when previous surgical attempts have failed.

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